# PATENT COOPERATION TREATY

# PCT



# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

(PCT Article 36 and Rule 70)

| Applicant's or agent's file reference<br>P1896PC00 | **FOR FURTHER ACTION** | See Form PCT/IPEA/416 |
|---|---|---|
| International application No.<br>PCT/FI2004/000691 | International filing date *(day/month/year)*<br>17.11.2004 | Priority date *(day/month/year)*<br>18.11.2003 |
| International Patent Classification (IPC) or national classification and IPC<br>G01W1/08 | | |
| Applicant<br>VAISALA OYJ | | |

1. This report is the international preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.
3. This report is also accompanied by ANNEXES, comprising:
   a. ☒ *sent to the applicant and to the International Bureau)* a total of 5 sheets, as follows:
      ☒ sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).
      ☐ sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.
   b. ☐ *(sent to the International Bureau only)* a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).

4. This report contains indications relating to the following items:

| | | |
|---|---|---|
| ☒ | Box No. I | Basis of the opinion |
| ☐ | Box No. II | Priority |
| ☐ | Box No. III | Non-establishment of opinion with regard to novelty, inventive step and industrial applicability |
| ☐ | Box No. IV | Lack of unity of invention |
| ☒ | Box No. V | Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement |
| ☐ | Box No. VI | Certain documents cited |
| ☐ | Box No. VII | Certain defects in the international application |
| ☐ | Box No. VIII | Certain observations on the international application |

| Date of submission of the demand | Date of completion of this report |
|---|---|
| 02.05.2005 | 23.01.2006 |
| Name and mailing address of the international preliminary examining authority:<br>European Patent Office - P.B. 5818 Patentlaan 2<br>NL-2280 HV Rijswijk - Pays Bas<br>Tel. +31 70 340 - 2040 Tx: 31 651 epo nl<br>Fax: +31 70 340 - 3016 | Authorized Officer<br>Passier, M<br>Telephone No. +31 70 340-4872 |

# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/FI2004/000691

## Box No. I Basis of the report

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.

   ☐ This report is based on translations from the original language into the following language , which is the language of a translation furnished for the purposes of:
   - ☐ international search (under Rules 12.3 and 23.1(b))
   - ☐ publication of the international application (under Rule 12.4)
   - ☐ international preliminary examination (under Rules 55.2 and/or 55.3)

2. With regard to the **elements*** of the international application, this report is based on *(replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report)*:

| | |
|---|---|
| **Description, Pages** | |
| 1-20 | as originally filed |
| **Claims, Numbers** | |
| 1-12 | received on 02.05.2005 with letter of 28.04.2005 |
| **Drawings, Sheets** | |
| 1/2, 2/2 | as originally filed |

   ☐ a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3. ☐ The amendments have resulted in the cancellation of:
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

4. ☐ This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).
   - ☐ the description, pages
   - ☐ the claims, Nos.
   - ☐ the drawings, sheets/figs
   - ☐ the sequence listing *(specify)*:
   - ☐ any table(s) related to sequence listing *(specify)*:

* *If item 4 applies, some or all of these sheets may be marked "superseded."*

# INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

International application No.
PCT/FI2004/000691

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

1. Statement

| | | | |
|---|---|---|---|
| Novelty (N) | Yes: | Claims | 1-12 |
| | No: | Claims | |
| Inventive step (IS) | Yes: | Claims | 1-12 |
| | No: | Claims | |
| Industrial applicability (IA) | Yes: | Claims | 1-12 |
| | No: | Claims | |

2. Citations and explanations (Rule 70.7):

**see separate sheet**

## Re Item V

**1. Prior Art**

The following documents are referred to:

**D1:** JUNHONG WANG ET AL: "Corrections of humidity measurement errors from the Vaisala RS80 radiosonde - application to TOGA COARE data"

**D2:** TURNER D D ET AL: "Dry bias and variability in Vaisala RS80-H radiosondes: the ARM experience"

**D3:** B. M. LESHT, S.J. RICHARDSON: "The Vaisala RS-80H Radiosonde Dry-Bias Correction Redux"

**2. Technical Field**

The invention relates to correcting humidity measurement results of a radiosonde.

**3. Novelty and Inventive Step (Article 33(1),(2),(3) PCT)**

1. The subject-matter of **claims 1, 9 and 11** is novel and involves an inventive step for the following reasons:

2. Document **D1** is considered as the closest state of the art. This document describes how a humidity value at a certain ambient temperature can be obtained from the ambient temperature and the humidity value at calibration temperature. In this way, a temperature dependence correction model is applied to the humidity at calibration temperature. Furthermore, a temperature correction is described, which corrects humidity measurements during the first phases of flight for the effect of heating the sensor arm prior to launch of the radiosonde.

3. The present invention as it is defined in the independent **claims 1, 9 and 11** differs from **D1** essentially in that it defines calculating error-corrected humidity as a function of a calculated humidity sensor temperature $T_u$, the measured environmental temperature $T_T$ and the measured environmental humidity $U_m$. The humidity sensor temperature $T_u$ is calculated from differences $\Delta T$ between the measured environmental temperature $T_T$ and humidity sensor temperature $T_u$, said differences $\Delta T_u$ being predefined and corresponding to at least one environmental conditions parameter value.

4. By correcting the measured humidity in this way, account is being taken of the fact that the humidity sensor temperature might deviate from the environmental temperature due to the effect of radiative heat exchange.

5. Hence, the technical problem solved by the present invention is improving the accuracy of the humidity measurements.

6. None of the other available documents disclose or suggest this way of correcting a measured environmental humidity. **D2** discusses calibration of radiosondes by scaling moisture profiles. **D3**, like **D1**, describes how a humidity value at a certain ambient temperature can be obtained as a function of that ambient temperature and the humidity value at calibration temperature.

7. **Claims 2-8, 10 and 12** are dependent on **claims 1, 9 and 11**, respectively, and as such also meet the requirements of the PCT with respect to novelty and inventive step.

**4. Industrial Applicability (Article 33(1),(4) PCT)**

The subject-matter of **claims 1-12** is industrially applicable.

**Other**

Documents **D1-D3** are not addressed in the description (R.5.1(a)(ii) PCT).

Claims:

1. A method for correcting humidity measurement results of a radiosonde in respect to errors resulting from radiative heat exchange, the radiosonde comprising at least a humidity sensor and a temperature sensor, **characterised** in that the method comprises the steps of:

determining correction values for humidity measurement results in different environmental conditions, said correction values being organized in a beforehand formed (10) data structure (20) or calculated by means of a beforehand determined mathematical function, said environmental conditions being determined as a function of at least one environmental conditions parameter, said environmental conditions parameter being a variable having an effect in the environment of the humidity sensor and said correction values being determined so that they correct errors resulting from radiative heat exchange,

measuring (12) environmental humidity $U_m$ with said humidity sensor,

determining a current value of at least one environmental conditions parameter,

measuring (11) the environmental temperature $T_T$ with said temperature sensor,

calculating (13) humidity sensor temperature $T_U$, by means of said measured environmental temperature $T_T$ and said correction values, which are differences $\Delta T_U$ between the measured environmental temperature $T_T$ and the humidity sensor temperature $T_U$ and correspond to the determined current value of said at least one environmental conditions parameter, and

calculating (14) error-corrected humidity U by means of the calculated humidity sensor temperature $T_U$, the measured environmental temperature $T_T$ and the measured environmental humidity $U_m$.

2. A method according to claim 1, **characterised** in that said environmental conditions parameter relates to at least one variable affecting the humidity

measurement result, such as pressure, environmental temperature, humidity, location altitude of the radiosonde, sounding time of the radiosonde, intensity of solar radiation, solar elevation angle, location of the radiosonde on the globe or ascending speed of the radiosonde.

3. A method according to any one of the preceding claims, **characterised** in that said differences $\Delta T_U$ between the environmental temperature $T_T$ and the humidity sensor temperature $T_U$ are determined based on comparison measurements.

4. A method according to any one of the preceding claims, **characterised** in that said differences $\Delta T_U$ between the environmental temperature $T_T$ and the humidity sensor temperature $T_U$ are determined as a function of air pressure P and solar elevation angle h.

5. A method according to any one of the preceding claims, **characterised** in that said differences $\Delta T_U$ between the environmental temperature $T_T$ and the humidity sensor temperature $T_U$ are determined as a function of saturation humidity rh dependent on temperature and of air pressure P.

6. A method according to any one of the preceding claims, **characterised** in that the method comprises

error-correcting the measured environmental temperature $T_T$ before calculating the humidity sensor temperature $T_U$, and

using the error-corrected environmental temperature $T_T$ in calculating the humidity sensor temperature $T_U$ and the error-corrected humidity U.

7. A method according to any one of the preceding claims, **characterised** in that the humidity sensor temperature $T_U$ is calculated in the following way:

$T_U = T_T + k_U \cdot \Delta T_U$, in which

$T_T$ = environmental temperature measured with temperature sensor advantageously error-corrected,

$k_U$ = ventilation factor in relation to a nominal value, and

$\Delta T_U$ = difference between environmental temperature and humidity sensor temperature in current environmental conditions.

8. A method according to any one of the preceding claims, **characterised** in that the error-corrected humidity U is determined in the following way:

$$U = \frac{e(T_T)}{e_w(T_T)} \cdot 100 = \frac{e_w(T_U)}{e_w(T_T)} \cdot U_m \text{, in which}$$

$T_T$ = environmental temperature measured with temperature sensor advantageously error-corrected,

$T_U$ = humidity sensor temperature,

$U_m$ = measured humidity,

$e_w(T_U)$ = partial pressure of saturated water vapour in temperature $T_U$,

$e_w(T_T)$ = partial pressure of saturated water vapour in temperature $T_T$, and

$e(T_T)$ = actual vapour pressure in temperature $T_T$.

9. A data processing device (30) for correcting humidity measurement results of a radiosonde in respect to errors resulting from radiative heat exchange, the radiosonde comprising at least a humidity sensor and a temperature sensor, **characterised** by the data processing device comprising:

a memory (33) comprising correction values for humidity measurement results in different environmental conditions, said correction values being organized in a beforehand formed data structure (35) or calculated by means of a beforehand determined mathematical function stored in the memory (33), said environmental conditions being determined as a function of said at least one environmental conditions parameter, said environmental conditions parameter being a variable having an effect in the environment of the humidity sensor and said correction values being determined so that they correct errors resulting from radiative heat exchange,

receiving means (32) for receiving environmental humidity $U_m$ measured with said humidity sensor and receiving environmental temperature $T_T$ measured with said temperature sensor and receiving the current value of at least one environmental conditions parameter, and

calculation means (31, 34) for calculating the humidity sensor temperature $T_U$ by means of said measured environmental temperature $T_T$ and said correction values, which are differences $\Delta T_U$ between the measured environmental temperature $T_T$ and the humidity sensor temperature $T_U$ and correspond to the current value of said at least one environmental conditions parameter and for calculating error-corrected humidity U by means of the calculated humidity sensor temperature $T_U$, the measured environmental temperature $T_T$ and the measured environmental humidity $U_m$.

10. A data processing device according to claim 9, **characterised** in that said data processing device is located in said radiosonde.

11. A computer program which provides a routine for correcting humidity measurement results of a radiosonde in respect to errors resulting from radiative heat exchange when running said computer program, the radiosonde comprising at least a humidity sensor and a temperature sensor, and said computer program communicating with

a memory comprising correction values for humidity measurement results in different environmental conditions, said correction values being organized in a beforehand formed data structure or calculated by means of a beforehand determined mathematical function stored in the memory, said environmental conditions being determined as a function of at least one environmental conditions parameter, said environmental conditions parameter being a variable having an effect in the environment of the humidity sensor and said correction values being determined so that they correct errors resulting from radiative heat exchange, said computer program comprising:

a program code for receiving environmental humidity $U_m$ measured with

said humidity sensor and receiving environmental temperature $T_T$ measured with said temperature sensor and receiving the current value of at least one environmental conditions parameter, and

a program code for calculating the humidity sensor temperature $T_U$ by means of the measured environmental temperature $T_T$ and said correction values, which are differences $\Delta T_U$ between the measured environmental temperature $T_T$ and the humidity sensor temperature $T_U$ and correspond to the current value of said at least one environmental conditions parameter and for calculating error-corrected humidity U by means of the calculated humidity sensor temperature $T_U$, the measured environmental temperature $T_T$ and the measured environmental humidity $U_m$.

12. A computer program according to claim 11, stored in a storage medium.